

JUN -9 1997

LEGAL ID#

DPG/PC P4934 DATE:

COPY 6731

It is important to provide accurate and detailed information on this form. The information will be used to evaluate your invention for possible filing as a patent application. When completed, please return this form to the Legal Department at JF3-147. If you have any questions regarding this form or to whom it should be forwarded, please call 264-0444.

## 1. Inventor(s):

Name: JOSEPH C. BARRETT ✓ SS# 573-02-7125  
 Empl. No. 10503357 Dept.# 100-76F1-6 Phone (916)356-9251 M/S: FMS-73  
 Home Address: 6145 HAGEN RANCH ROAD EL DORADO, CA 95623  
 Citizenship: USA Supervisor MIKE BARROW Phone (916)356-3444 M/S: FMS-73  
 Group Name: DESKTOP PRODUCTS Division Name: PLATFORM COMPONENTS

Name: \_\_\_\_\_ SS# \_\_\_\_\_  
 Empl. No. \_\_\_\_\_ Dept.# \_\_\_\_\_ Phone \_\_\_\_\_ M/S: \_\_\_\_\_  
 Home Address: \_\_\_\_\_  
 Citizenship: \_\_\_\_\_ Supervisor \_\_\_\_\_ Phone \_\_\_\_\_ M/S: \_\_\_\_\_  
 Group Name: \_\_\_\_\_ Division Name: \_\_\_\_\_

(PROVIDE SAME INFORMATION AS ABOVE FOR EACH ADDITIONAL INVENTOR)

2. Title of Invention: PLASTIC BALL GRID ARRAY PACKAGE WITH REINFORCED CORNERS

3. Stage of development, i.e. % complete, and relation of technology to the following product/process: \_\_\_\_\_

4. (a) Has a description of your invention been, or will it shortly be, published outside Intel:

NO: X YES: \_\_\_\_\_ DATE WAS OR WILL BE PUBLISHED: \_\_\_\_\_

If YES, was the manuscript submitted for pre-publication approval? YES: \_\_\_\_\_ NO: \_\_\_\_\_

(b) Has your invention been used/sold or planned to be used/sold by Intel or others?

NO: X YES: \_\_\_\_\_ DATE WAS OR WILL BE SOLD: \_\_\_\_\_

5. If invention conceived, or constructed during performance of a government or third party contract, please check here \_\_\_\_\_ and give the contract name and number \_\_\_\_\_

6. Please attach a page to this form, DATED AND SIGNED BY ONE INVENTOR (PREPARER), to provide an abstract of your invention, and include the following information in your abstract:

- (a) State general purpose(s) of your invention;  
 (b) Describe advantage(s) of your invention over what is done now;  
 (c) Describe essential element(s) or key to your invention; and  
 (d) Value of your invention to Intel (how will it be used?).

RECEIVED

JUN 12 1997

B.S.T.Z. DATABASE DEPT.

\*HAVE YOUR SUPERVISOR READ, DATE AND SIGN COMPLETED FORM

DATE: 5/29/97SUPERVISOR: Barrow

BY THIS SIGNING, I (SUPERVISOR) ACKNOWLEDGE THAT I HAVE READ AND UNDERSTAND THIS DISCLOSURE, AND RECOMMEND THAT THE HONORARIUM BE PAID.

RECEIVED

SEP 18 1997

REV. 11

A.W.D.

### General Purpose of Invention

This invention involves changing the shape of the plastic overmold on the Plastic Ball Grid Array (PBGA) package so as to increase the mechanical strength of the package corners, rendering them less susceptible to mechanical damage.

### Advantages of Invention over what is done now

Currently, the corners of PBGA packages are unsupported, consisting only of the substrate material, which includes printed circuit traces and dielectric material, and solder balls. The substrate material is thin, being normally in the range of .36 to .65 millimeters (.014 to .026 inches) thick. As a result of this construction, the corners of the package may be easily damaged, either during processing in packages assembly, test, and assembly to motherboard, or during normal handling.

This invention reinforces the corners of the package by selectively extending the mold compound into the corners to add the strength of the mold compound to that of the substrate material.

Note that it is crucial that the mold compound be extended selectively into the package corners. Extending the mold compound completely to the package edges around the perimeter of the package would result in excessive warpage of the package during the molding process. By extending the mold compound selectively into the corners, the strength of the package is improved without inducing warpage problems. Additionally, the molding process relies on exposed edges of the substrate to properly clamp the part into the mold cavity during the molding process. Selectively extending the mold compound into the package corners leaves the edges of the part available for clamping during the mold operation.

Figures 1 through 4 illustrate the key differences between current practice and the proposed invention.

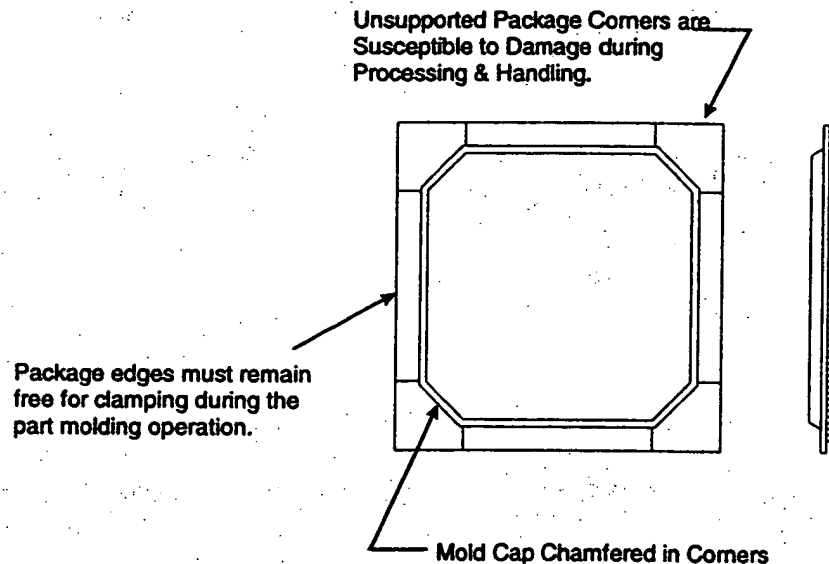


Figure 1  
Current PBGA Package Design

BEST AVAILABLE COPY

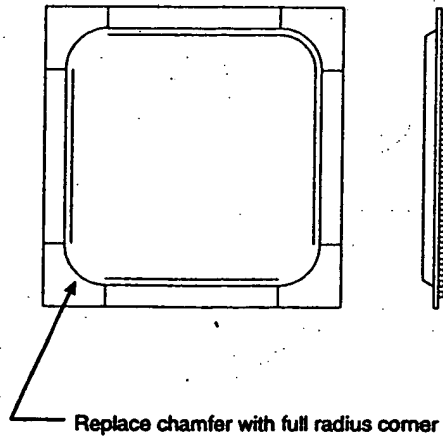


Figure 4  
Version #3

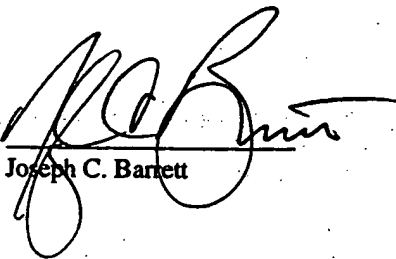
In version #3, mold compound is extended into the package corners by replacing the chamfers at the corners of the mold cap in the existing package design with full radius corners. This version has the advantage of further reducing the risk of package warping after the molding operation over versions #1 and #2, although the reinforcement of the package corners is less than that provided in either of the preceding versions.

Essential Elements or Key to the Invention

The essential element of this invention is the selective extension of mold compound material into the corners of the PBGA, gaining additional strength for the package corners while avoiding excessive part warp and preserving compatibility of the package design with the molding process.

Value of Invention to Intel

Intel is the largest producer of PBGA parts in the world. The PBGA parts used by PCD are assembled in Korea and shipped to Penang for test. After test, the parts are shipped worldwide for use by our myriad customers. Several parts have been damaged during assembly, test, and/or shipping, resulting in customer problems and field returns. Implementation of this invention will prevent the opportunity for package damage eliminating this potential source of failures from our product line.

  
Joseph C. Barrett

BEST AVAILABLE COPY

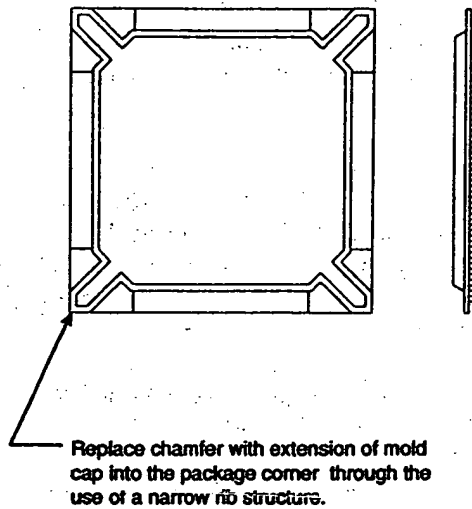


Figure 2  
Version #1

In version #1, narrow ribs of mold compound are extended into the package corners to reinforce the corners. This version provides maximum reinforcement to the package corners, although at the risk of potential package warpage during the molding operation, due to uneven shrinkage between the mold compound and the substrate material.

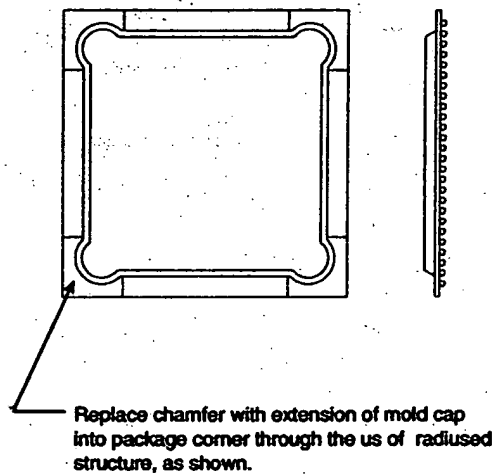


Figure 3  
Version #2

In version #2, mold compound is extended into the package corners by implementing radiused protrusions at each corner of the package mold cap. This version has the advantage of reducing the risk of package warping after the molding operation, although the reinforcement of the package corners is less than that provided in version #1.

# BEST AVAILABLE COPY

## General Purpose of Invention

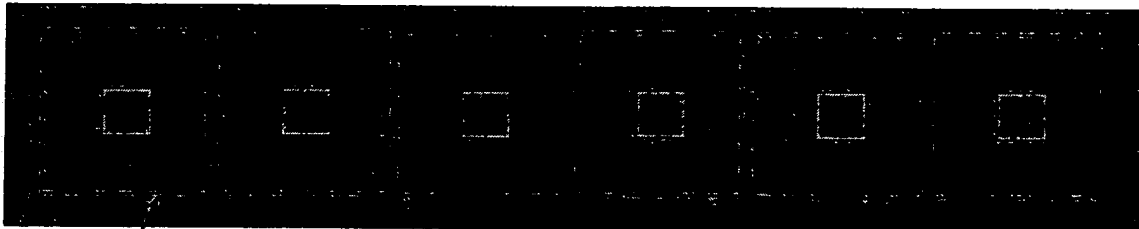
Contamination of component handling, assembly, and test equipment is reduced by eliminating solder mask from the edge of the plastic ball grid array (PBGA). This eliminates the generation of solder mask flakes from the edge of the part during handling. Further, the incidence of cracks in the solder mask, and its attendant reliability issues, is reduced by eliminating solder mask from the edge of the part.

## Advantages of Invention over What is Done Now

Currently, solder mask is applied over the entire surface of PBGA substrates during the substrate manufacturing process. The function of the solder mask is to prevent solder flow from the solder balls down substrate traces during ball attach and assembly of the PBGA to a printed circuit board. In addition, solder mask provides a good adhesion surface for die attach and overmold.

Substrates and PBGA parts are processed as strips during assembly, as shown in Figure 1. Upon completion of PBGA assembly, the individual PBGAs are separated, or singulated from the strip through the use of a shear punch or routing operation. Because the solder mask material is brittle, the singulation step tends to introduce cracks into the solder mask and pieces of solder mask to flake off of the singulated parts. Two problems result. The cracks in the solder mask result in stress concentrations. As a result, the cracks will tend to propagate into the material below, which is either printed circuit board laminate or copper traces. Cracked copper traces can result in part functional failure. The second problem is contamination of equipment and parts by solder mask flakes. In particular, the solder mask flakes have contaminated test sockets used in final product test, resulting the need for increased cleaning of the sockets to maintain production. In assembly sites, solder mask flakes have been known to migrate upstream to parts in wirebond, with contaminated substrates resulting in poor quality wirebond with subsequent part failure and scrap.

This invention redefines the location of the solder mask such that while the solder mask extends over most of the surface of the PBGA so as to provide necessary protection for the solder balls and adhesion for die attach and overmold, it does not extend to the edge of the singulated part. See Figures 2 & 3. By removing solder mask from the part edge area, it is protected from cracking and flaking during the singulation process.



Dashed lines indicate the edges of completed PBGAs.

Figure 1  
Current PBGA Strip Design

# BEST AVAILABLE COPY

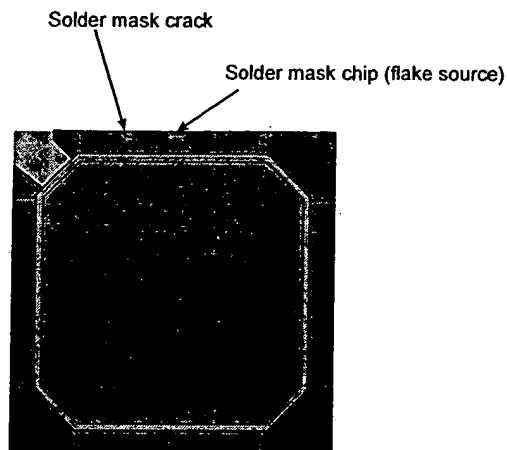


Figure 2  
PBGA Part Illustrating Nature of Cracks Generated in Current Designs

Shaded area illustrates areas where solder mask is eliminated in this invention.

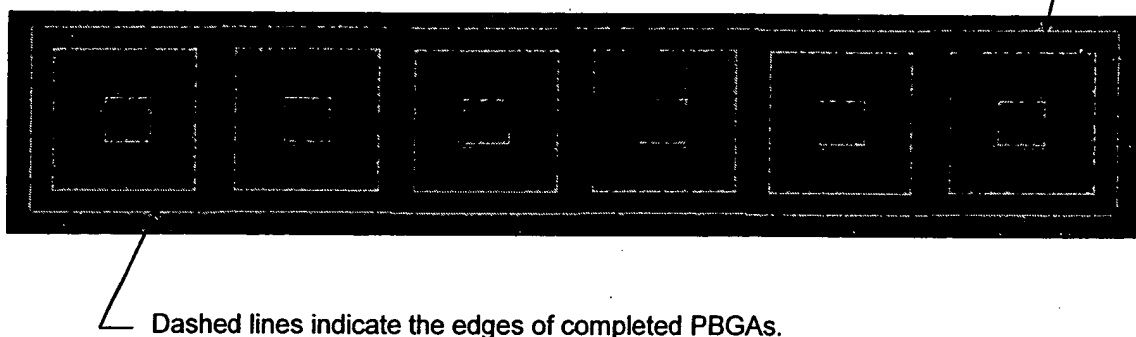


Figure 3  
PBGA Strip Illustrating Solder Mask Free Zones as Proposed by Invention

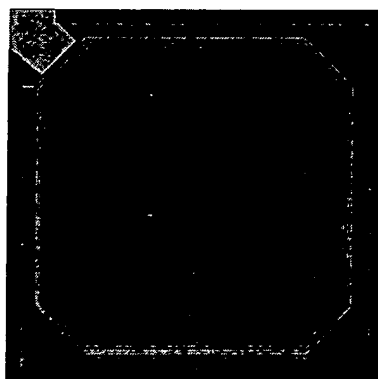


Figure 4  
Singulated Part Illustrating Soldermask Free Edge

Essential Elements or Key to the Invention

The essential element of this invention is the removal of solder mask from the edge of the part thus preventing the generation of solder mask cracks and flakes. This in turn reduces the potential for failed parts through the elimination of solder mask cracks and contamination of assembly test hardware by solder mask flakes.

Value of Invention to Intel

Intel is the largest producer of PBGA parts in the world. Solder mask cracks have been detected in a number of PBGA parts, and solder mask flakes are contaminating test sockets at our PBGA test sites. Further, copper trace failures have been traced to solder mask cracks in at least 2 cases. This invention will eliminate this source of failure from PBGA assembly lines.

---

Joseph C. Barrett